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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/608,313	06/30/2000	Gerolf F. Hoflehner	042390.P8132	9388

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EXAMINER

SHRADER, LAWRENCE J

ART UNIT	PAPER NUMBER
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2124

DATE MAILED: 11/20/2003

10

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/608,313

Applicant(s)

HOFLEHNER ET AL.

Examiner

Lawrence Shrader

Art Unit

2124

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 October 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1 - 80 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1- 38, 40 - 78, and 80 is/are rejected.
- 7) ☒ Claim(s) 39 and 79 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
- a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

1. This action is responsive to the Applicant's Request for Continued Examination filed on October 20, 2003.
2. Claims 1 – 38, 40 – 78, and 80 remain rejected.
3. The Applicant's arguments filed on April 21, 2003 have been fully considered but they are moot in view of new grounds of rejection.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 28 – 34, 37, 40; 68 – 74, 77, and 80 are rejected under 35 U.S.C. 102(b) as being anticipated by Wu, U.S. Patent 6,230,317.

In regard to claim 28:

a) *performing a first allocation...* Wu teaches allocation of register space at the entry block of a routine (column 3, line 64 to column 4, line 28)

b) *performing a second allocation...* Wu teaches allocation of a second amount of register space for live information (the loop routine contains information; column 4, lines 1 – 15).

c) *performing a function call...* The second routine (loop) is called (column 4, lines 11 – 21).

d) *performing a third allocation...* Wu teaches a third allocation with an overlapping registers space (see Figure 3 and column 4, lines 14 – 17)

In regard to claim 29, incorporating the rejection of claim 28:

“...said live information is determined by identifying information that is referred to before and after said function call.” The live data is inherently included based on information referred to before and after the function call.

In regard to claim 30, incorporating the rejection of claim 29:

“...information identified after said function call extends to an exit block of said routine.” (e.g., see Figure 2b)

In regard to claim 31, incorporating the rejection of claim 30:

“...the worst case path to said exit block is allocated for.” (see figure 2b)

In regard to claim 32 and 33 incorporating the rejection of claims 29 and 32 respectively:

“...information identified after said function call extends to a post-dominator block of said routine.” It is understood that a function call extending to an exit block would inherently apply as well to a post-dominator block since the type of flow graph would not alter the method. *“...the worst case path to said post-dominator block is allocated for.”* (see figure 2b)

In regard to claim 34, incorporating the rejection of claim 28:

"...said live information is information that is local to said routine." The information in the loop function is live information (Figure 2b).

In regard to claim 37, incorporating the rejection of claim 28:

"...said second allocation is performed just before said function call." The second storage area is allocated before the function is called (column 4, lines 9 – 14).

In regard to claim 40, incorporating the rejection of claim 28:

"...compiling said routine." Compiling or interpreting is an inherent step of preparing a routine to run a computer system.

As to claims 68 – 74, 77, and 80, they are rejected for the same reasons as put forth for claims 28 – 34, 37, and 40 above, the claims being a machine-readable medium version of the claimed method discussed and/or addressed above in claims 28 – 34, 37, and 40.

As to claim 1, rejected for the same reasons put forth in the rejection of claim 37 above.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 1, 11 – 16, 19, 20, 23, and 24; 41, and 51 – 53; 54 – 56, 59, 60, 63, and 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith, U.S. Patent 5,367,684 in view of Orr, U.S. Patent 5,748,963.

In reference to claim 1, the allocation instruction in claim 37 is inherently present in order to guide the allocation of memory. However, assuming it is not, then the insertion of an allocation instruction follows according to claim 1. Smith discloses a register allocator, which allocates registers to instructions of each basic block of code (column 7, lines 9 – 15), and inserts spill instructions (column 7, lines 16 – 21) into the block of instructions based on a live range, but does not explicitly teach the identification of a function call as the indicator of a block, although one skilled in the art could infer that the Smith invention refers to function blocks (e.g., see Figure 7f). Orr, however, explicitly teaches the determination of an instruction in the form of a function call in a code segment (column 7, lines 42 – 45) in order to replace the parameters with a dictionary entry. Therefore, it would have been obvious to one skilled in the art at the time the invention was made to combine the function call identification method of Orr with the instruction identification and insertion feature taught by Smith invention, which clearly locates a basic block of code in a program (and a function defines a basic block of code) in order to insert a spill instruction to allocate memory, because one skilled in the art would understand that a function call is an instruction that the Smith invention would recognize as identifying a block of code.

In reference to claim 11, official notice is taken for allocation of an instruction inserted just before the function-call, because one of ordinary skill would expect that the proper allocation configuration be made *before* the function runs. Therefore, it would

have been obvious to one skilled in the art at the time the invention was made to insert an allocation instruction before the function call so that the allocation of resources for the function is complete before the function is run.

In reference to claims 12 and 13, official notice is taken for allocation of an instruction inserted before the function-call because one of ordinary skill in the art would expect that the proper allocation configuration be made before the function runs. Also, a pre-dominator block implies a dominator block, which in turn implies that a post-dominator block exists, i.e., a block being dominated. Therefore, it would have been obvious to one skilled in the art at the time the invention was made to insert an allocation instruction before the function call, whether or not in a pre-dominator block, so that the allocation of resources is complete before the function is run.

In reference to claim 14, rejected for the same reasons put forth in the rejection of claim 1. Claim 14 would simply multiply the insertion of allocation instructions whenever a functional characteristic is found after searching. Therefore, it would have been obvious to one skilled in the art at the time the invention was made to search for multiple functional characteristics and apply the allocation instruction insertions in order that each functional routine or block of code might contribute to the greater efficiency of the program.

In reference to claims 15, 19, and 23, rejected for the same reasons put forth for claim 1. A functional characteristic corresponding to either a loop in a control flow graph, or a software pipelined loop may be interpreted as a routine resulting from a function call. In the case of a loop, a section of code need not be repeated as inline code;

in the case of a software pipelined loop, the function may be utilized so that the code might be optimized for greater throughput.

In reference to claims 16 and 20, rejected for the same reason put forth in the rejection of claim 11.

In reference to claim 24, a method for determining the number of registers to be allocated for an allocation instruction inherently follows an analysis of functional characteristics of the routine.

Claims 41, and 51 – 53 (the medium) are rejected for the same corresponding reasons put forth for claims 1, and 11 – 13 (the method).

Claims 54 – 56, 59, 60, 63, and 64 (the medium) are rejected for the same corresponding reasons put forth for claims 14 – 16, 19, 20, 23, and 24 (the method).

8. Claims 2, 8 – 10; 42, and 48 – 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith, U.S. Patent 5,367,684 in view of Orr, U.S. Patent 5,748,963, as applied to claim 1 above, and further in view of Proebsting et al., “Demand Driven Register Allocation” (hereinafter referred to as Proebsting).

In reference to claim 2, Smith discloses allocation instructions, and Orr teaches the determination of a function call in a routine. Neither Smith nor Orr teaches allocation for only live information, but Proebsting teaches the allocation of registers for live information (page 683, Abstract). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to combine the disclosures of Smith and Orr

in order to insert allocation instructions in a routine if a function call instruction is found and to further modify the combination with the use of live data as taught by Proebsting so that only useful information is stored.

In reference to claim 8, Proebsting teaches local values to allocate registers to the given routine (page 1, Abstract) as applied to claim 2.

In reference to claim 9, Smith discloses allocation instructions, and Orr teaches the determination of a function call in a routine. Neither Smith nor Orr teaches a register space partitioned for global variables and one for local variables with said instruction allocating local register space. Proebsting teaches the allocation of both local and global registers (page 1, Abstract). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to construct an allocation instruction according to the combination of Smith and Orr and further implement the instruction with the ability to partition register space for local variables, while allocating global registers by another means, as taught by Proebsting.

In reference to claim 10, Smith discloses allocation instructions, and Orr teaches the determination of a function call in a routine. Neither Smith nor Orr teaches allocation for live information that is global information, but Proebsting teaches the allocation of registers for global live information (page 1, Abstract). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to combine the function call identification method of Orr with the insertion of allocation instructions taught by Smith in order to insert allocation instructions in a routine if a function call instruction is found, and further modified by Proebsting to include live variable

information that is global so that a single register might be allocated for several variables that are not simultaneously live.

Claims 42, and 48 - 50 (the medium) are rejected for the same corresponding reasons put forth for claims 2, and 8 - 10 (the method).

9. Claims 3 - 7; 17, 18, 21, 22, 25 - 27; 43 - 47; 57, 58, 61, 62, and 65 - 67 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith, U.S. Patent 5,367,684 in view of Orr, U.S. Patent 5,748,963, and further in view of Proebsting et al., "Demand Driven Register Allocation" (hereinafter referred to as Proebsting), as applied to claim 2 above, and further in view of Srivastava, U.S. Patent 5,999,737.

In reference to claims 3, 4, and 6 Smith discloses allocation instructions, and Orr teaches the determination of a function call in a routine; Proebsting teaches the allocation of live information for both local and global registers. None specifically teach the method of determining live information by identifying information that is referred to before and after a function call (claim 3) and extending to the exit block of the routine (claim 4) or a post-dominator block (claim 6) - it is understood that a function call extending to an exit block would apply as well to a post-dominator block since the type of graph would not alter the method. Srivastava, on the other hand, teaches a liveness analysis wherein a set of live variables is determined at the beginning of execution of a function call and also at the end of the function call (column 8, lines 6 - 12); the liveness analysis also extends to the exit block, or a post-dominator, of the routine (10, lines 12 - 26). Therefore, it would have been obvious to one skilled in the art at the time

the invention was made to insert an allocation instruction as determined by the combination of the disclosures of Smith and Orr, and configuring the instruction to allocate only live information as modified by Srivastava, where said information is referred to both before and after a function call, and where the identified information extends to an exit block of the routine also taught by Srivastava so that resources are efficiently allocated for only useful data, and for increasing the efficiency of the compiled program.

In reference to claims 5 and 7, official notice is taken that none of the cited references work specifically to eliminate a worst-case path, therefore, one may infer that the worst-case path may be allocated, especially in Probsting and Srivastava.

In reference to claims 17 and 21, rejected for the same reason put forth in the rejection of claim 5.

In reference to claims 18, rejected for the same reason put forth in the rejection of claim 7.

In reference to claim 22, rejected for the same reason put forth in the rejection of claim 6.

In reference to claims 25 and 26, rejected in line with the reasoning for claim 24. Functional characteristics must be known before a determination of a consequent action can be made.

In reference to claim 27, building an understanding of a flow control graph is inherent in a compiling procedure, therefore, searching could not be done prior to the understanding.

Claims 43 – 47 (the medium) are rejected for the same corresponding reasons put forth for claims 3 – 7 (the method).

Claims 57, 58, 61, 62, and 65 – 67 (the medium) are rejected for the same corresponding reasons put forth for claims 17, 18, 21, 22, and 25 – 27 (the method).

10. Claims 35, 36, and 38; 75, 76, and 78 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wu, U.S. Patent 6,230,317, as applied to claim 28 above, in view of Proebsting et al., “Demand Driven Register Allocation” (hereinafter referred to as Proebsting).

In regard to claim 35, incorporating the rejection of claim 34:

“...associated register space partitioned into register space used only for local information and register space used only for global information, said allocation instruction pertaining only to said register space for local information.” Wu teaches register storage allocation, but does not teach partitioning of register space. However, Proebsting teaches allocation of both local and global registers (page 683, Abstract). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to allocate register space according to the teaching of Wu and further implement the instruction with the ability to partition register space for local variables, while allocating global registers by another means, as taught by Proebsting, because Proebsting teaches that local allocation precedes global allocation, which is done

iteratively in nested loops (Abstract), which would apply to the nested loop feature of Wu.

In regard to claim 36, incorporating the rejection of claim 28:

“...live information includes global information.” Wu teaches register storage allocation, but does not specifically teach that live information includes global information. However, Proebsting teaches that global information includes global information (page 683, Abstract). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to allocate register space with live local information according to the teaching of Wu and further implement the instruction with the ability to include live global information as taught by Proebsting, because Proebsting teaches that local allocation precedes global allocation over live ranges, which is done iteratively in nested loops (Abstract), which would apply to the nested loop feature of Wu.

In regard to claim 38, incorporating the rejection of claim 28:

“...second allocation is performed in a pre-dominator basic block of said function call.” Wu teaches register storage allocation, but does not teach allocation performed in a pre-dominator block of the function call. However, Proebsting allocation performed in a pre-dominator block (pre-header; e.g., see Figure 10). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to allocate register space according to the teaching of Wu and further implement the ability to allocate in a pre-dominator basic block as taught by Proebsting, because Proebsting teaches that the pre-header is also considered to be a register-definition of every variable since loads can be added there as needed (page 692, first para. of section 3.5).

As to claims 75, 76, and 78, they are rejected for the same reasons as put forth for claims 35, 36, and 38 above, the claims being a machine-readable medium version of the claimed method discussed and/or addressed above.

Allowable Subject Matter

11. Claim 39 (the method) and claim 79 (the machine readable medium) is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

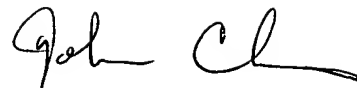
12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lawrence Shrader whose telephone number is (703) 305-8046. The examiner can normally be reached on M-F 08:00-16:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kakali Chaki can be reached on (703) 305-9662. The fax phone number for the organization where this application or proceeding is assigned is (703) 746-7239.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.

Lawrence Shrader
Examiner
Art Unit 2124

November 6, 2003

A handwritten signature in black ink, appearing to read "John Chavis". The signature is fluid and cursive, with a long horizontal stroke at the end.

JOHN CHAVIS
PATENT EXAMINER
ART UNIT 2124